FOREST PEST MANAGEMENT
Pacific Southwest Region

Report No. 86-9

3420 Pest Management Evaluations
June 30, 1986

# MOUNTAIN PINE BEETLE ACTIVITY IN THREE STANDS OF LODGEPOLE PINE NEAR TRUCKEE, CALIFORNIA

John W. Dale, Entomologist
John Kliejunas, Plant Pathologist

## ABSTRACT

Three lodgepole pine stands on the Truckee Ranger District and adjacent to a residential development were examined for current and past activity of the mountain pine beetle, Dendroctonus ponderosae. Activity has been chronic in most of the area, and one stand contained many green trees with live brood. Old Jeffrey pine and white fir stumps with signs or symptoms of annosus root disease were common. Six management alternatives ranging from no action to management of annosus root disease are discussed.

## INTRODUCTION

Mountain pine beetles, Dendroctonus ponderosae Hopkins, have been attacking lodgepole pine southwest of Prosser Lake for several years. Dead pine have been salvaged from three stands on public land (Fig. 1) and sold in firewood sales. This reclaims some of the value lost, but it does not address the conditions pertinent to management of these stands that would alleviate losses and improve tree and stand vigor. The Truckee Ranger District, Tahoe National Forest, therefore requested a pest management evaluation as part of an overall environmental assessment of management alternatives for these stands, which are adjacent to a private residential development to the south and a public recreation area to the north. We met with personnel from the District on May 6 and surveys and examinations were conducted May 6-8, 1986.

## DESCRIPTION

The three stands are located two miles north of Truckee, California, via State Route 89 (Fig. 1). Elevation is 5800 ft, aspect is northeast and slope is generally 10%. Stands 389 and 391 are Dunning Site Class IV and consist of small sawtimber lodgepole pine, with minor components of white fir, ponderosa and Jeffrey pine. Stand 388 is a Dunning V and has a small component of Jeffrey pine. Aggregation descriptions from a recent cruise are given in Table 1. The larger trees of all species are about the same age, 120 years, with the last 40 years producing only one inch of radial growth for the lodgepole pine.

USDA, FOREST SERVICE, PACIFIC SOUTHWEST REGION
State and Private Forestry, Forest Pest Management
630 Sansome Street, San Francisco, California 94111

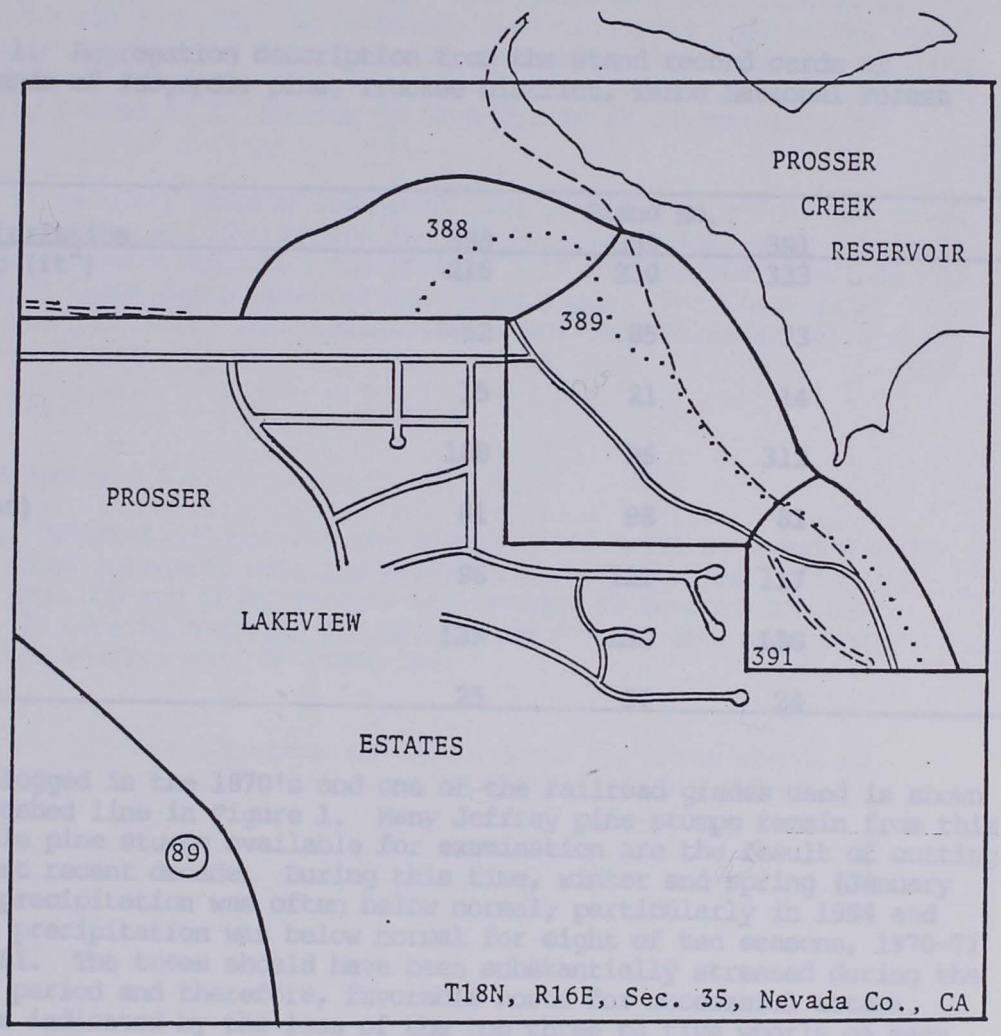


Figure 1. Three stands near Truckee, California where mountain pine beetle is causing mortality of lodgepole pine. The dotted line and property lines enclose the area where most of the spot infestations occur.

Radial growth of the white fir was about twice that of the lodgepole for the same period. The last recorded infestation in the Prosser Creek drainage was in 1964. Thus, the Prosser stands have all the characteristics of a highly susceptible stand: dbh greater than 8", greater than 80 years of age, a pure or nearly pure lodgepole type for much of the area, an elevation and latitude conducive to population increase, and a history of infestation.

Table 1. Aggregation description from the stand record cards of three stands of lodgepole pine, Truckee District, Tahoe National Forest

| | Stand No. | | |
|---|---|---|---|
| Stand Characteristics | 388 | 389 | 391 |
| Basal Area/ac ($ft^2$) | 216 | 230 | 333 |
| Height (ft) | 52 | 85 | 73 |
| dbh (in) | 15 | 21 | 14 |
| Stems/ac | 188 | 96 | 312 |
| Growth ($ft^3$/ac) | 81 | 98 | 81 |
| Age (yrs) | 96 | 122 | 117 |
| Stratum | L3N | L3G | L3G |
| Area (ac) | 25 | 37 | 24 |

The area was logged in the 1870's and one of the railroad grades used is shown as a single dashed line in Figure 1. Many Jeffrey pine stumps remain from this era. Lodgepole pine stumps available for examination are the result of cutting within the most recent decade. During this time, winter and spring (January through May) precipitation was often below normal, particularly in 1984 and 1985. Annual precipitation was below normal for eight of ten seasons, 1970-71 through 1980-81. The trees should have been substantially stressed during the beetle flight period and therefore, favorable hosts for successful attack. This stress is indicated by the loss of the top three to five whorls on many pines in these stands.

## METHODS

Cruise strips one chain wide were begun two chains north of the southwest corner of each stand and run east to west. Whenever a dead or green-infested lodgepole pine was encountered along the line, a variable plot sample (20 factor) was established at the center line at a right angle to the specimen tree. All trees greater than 4.5 inches dbh were tallied and classified as uninfested, attacked in 1985, attacked in 1984, or attacked in 1983 or before. Trees that had repulsed, "pitched-out", attacking beetles also were recorded. Presence or absence of brood, presence of parent adults, emergence holes, blue stain, phloem and sapwood disintegration, and needle fall were used to age tree mortality by the years indicated.

Two strips were run in stand 388, five in stand 389 and three in stand 391. Thus, 22% of the area was traversed — 20% for 388, 25% for 389, and 19% for 391.

Most of the stumps within the strips, and many outside, were examined for signs and symptoms of annosus root disease. The Jeffrey pine and white fir stumps were present from logging many years ago, and therefore, were relatively well-broken down and decayed. In contrast, most lodgepole pine stumps were created three to seven years ago, when the trees were killed by the mountain pine beetle and cut for fuelwood. These hard, non-decayed stumps would not enable fruiting bodies of F. annosus to have formed if colonization had occurred.

To determine if recently created lodgepole pine stumps were colonized, discs were cut with a chain saw from stumps in four locations, including the areas with identified annosus centers. The surface 1/2" was removed, and then two consecutive 1/2" thick discs were cut from each stump. The discs were incubated in the laboratory and examined after one and two weeks for the presence of the fungus.

## RESULTS

### Mountain Pine Beetle

The cruise for infestation data did not always yield basal area and average diameters in close agreement with the previous district cruise (Table 2). Different methodology and prism factors are thought to account for the differences. In general however, the stands are overstocked, with the exception of the western half of stand 388.

Table 2. Average diameters and basal areas for three stands of lodgepole pine, Truckee District, Tahoe National Forest

| Stand: | 388 | | 389 | | 391 | |
|---|---|---|---|---|---|---|
| | dbh | BA | dbh | BA | dbh | BA |
| District Cruise (Table 1) | 15 | 216 | 21 | 230 | 14 | 333 |
| MPB Cruise (range) | 13.8 | 148 ( 60-260) | 13.4 | 275 (160-340) | 14.4 | 210 (160-260) |

The dotted line and property lines of Figure 1 enclose the area where most of the spot infestations occur. Overall, more pines were attacked in 1985 than in previous years (Table 3). Basal area per dead tree also increased. The number of sample points initiated by encountering trees with 1985 attacks was about twice the number of points initiated by encountering attacks from previous years. The average diameter of attacked trees has increased slightly over time (Table 4). Increases in diameter and basal area indicate that more bole area contributed to brood production in 1985. Good brood survival in the thick phloem of these pines suggest a greater beetle population in 1986 than in previous years.

Table 3. Characteristics of lodgepole pine attacked by mountain pine beetle in three stands, Truckee District, Tahoe National Forest

| | 1985 | 1984 | 1983+* | Pitch-out |
|---|---|---|---|---|
| No. Dead Pines | 27 | 21 | 23 | 3 |
| Total BA Killed ($ft^2$) | 38.4 | 20.7 | 25.7 | 9.1 |
| BA/Dead Pine | 1.4 | 1.0 | 1.2 | 3.0 |

* = 1983 + years prior to 1983.

Stand 389 is largely responsible for these trends because most of the 1985 attacks were located in this stand (Table 4). Many potential "bug" trees remain in each stand — 63.5% of the uninfested lodgepole and ponderosa pines are greater than 12 inches dbh and have a phloem thickness of 2.3 mm or more. Phloem of 4.6 mm is not uncommon in some parts of stand 388. Thick phloem in attacked trees can result in good brood survival and rapid population increase.

Table 4. Average dbh of lodgepole and ponderosa pine in three stands near Prosser Creek, Truckee District, Tahoe National Forest

| | | Attacked by Mountain Pine Beetle | | |
|---|---|---|---|---|
| Stand No. | Uninfested | 1985 | 1984 | 1983+* |
| 388 | 11.8 | 19.6 | 12.5 | 15.6 |
| | (35) | (03) | (07) | (06) |
| 389 | 13.1 | 14.8 | 14.0 | 11.2 |
| | (77) | (19) | (02) | (05) |
| 391 | 14.1 | 13.6 | 14.2 | 13.8 |
| | (52) | (05) | (11) | (12) |
| All stands | 13.1 | 15.1** | 13.6 | 13.7 |

() = No. of trees.
* = 1983 + years prior to 1983.
** 14.5 for #389 + #391 only.

**Annosus Root Disease**

The stumps of some Jeffrey pine and white fir had typical annosus decay, but only stumps with conks of the pathogen were recorded as positive (Table 5). Frequency (%) of stumps colonized was about what would be expected from surveys in other stands in the Sierra Nevada.

Table 5. Frequency of F. annosus colonization of stumps in three lodgepole pine stands, Truckee District, Tahoe National Forest

| Species | Total Number of Stumps Examined | F. annosus Conks Present | |
|---|---|---|---|
| | | Number | Percent |
| Jeffrey pine | 63 | 12 | 19 |
| Lodgepole pine | 66 | 0 | 0 |
| White fir | 6 | 4 | 67 |
| TOTAL | 135 | 16 | 12 |

If the area surveyed was representative, about one infested stump per acre was present. However, infested stumps were concentrated rather than randomly distributed. None were found in 388; most were in 389 and a few were in 391. One old, inactive annosus center, about 1/4 acre in size and with no recent mortality, and one smaller center with a recently dead white fir, were present in the western portion of 389.

F. annosus was present in some of the discs removed from non-decayed lodgepole stumps (Table 6). Because most of the lodgepole pine stumps sampled were created when dead trees were cut, colonization by F. annosus was not expected to be common. Many of the discs were colonized by blue stain fungi. Blue stain, plus other saprophytic fungi colonizing dead tissues, would compete with F. annosus and make colonization difficult. Annosus infection of stumps created when live trees are cut would probably be greater.

Table 6. Colonization of lodgepole pine stumps by F. annosus in lodgepole pine stands 389 and 391 on the Truckee District, Tahoe National Forest

| Location | Lodgepole Pine Stumps | |
|---|---|---|
| | No. Sampled | No. with Fomes |
| 1 | 4 | 1 |
| 2 | 5 | 0 |
| 3 | 5 | 1 |
| 4 | 4 | 0 |

## DISCUSSION

Prospects for 1986 are for a larger beetle population than in previous years. This generation of mountain pine beetles will emerge into stands that remain highly susceptible to this insect because of overstocking, poor tree vigor, annosus root disease, and a high percentage of large lodgepole pines with thick phloem. The recent chronic tree moratlity is likely to continue until these stand conditions are altered either by natural successionary forces including beetles and F. annosus, or planned management activities. The former may be incompatible with management objectives; the latter may be preferable in spite of the investments required.

Any management activities should have as their goal the general concept of minimizing mountain pine beetle damage to lodgepole pine by maintaining healthy, vigorous and fast-growing stands, more or less regardless of age. It is not necessary to grow small-diameter trees with thin phloem in order to avoid damage from the mountain pine beetle. With intensive management, lodgepole pine can probably be grown to small sawtimber without significant loss from mountain pine beetles (Executive Summary, State-of-the-Art: Lodgepole Pine/Mountain Pine Beetle Management, Canada/U.S. Lodgepole Pine/Mountain Pine Beetle Program).

## MANAGEMENT ALTERNATIVES

1. **Do Nothing.** The mountain pine beetle will remain active in the stands, very likely in increasing numbers. Once the beetle greatly reduces the stocking and eliminates the larger trees with the thick phloem that result in high progeny production, the infestation will decline. This will take several more years to occur; just how long is hard to say for the infestation is not yet widespread. Only low temperatures atypical of Truckee could terminate the infestation under current stand conditions. However, stand conditions would remain unaltered and the beetle population would soon return to previous levels. The result will be increasing numbers of holes in the stands and standing dead pines. Additional lodgepole mortality can be expected in adjacent moderate- to high-risk unmanaged stands.

2. **Salvage Logging.** Value in the form of firewood sales would be realized, but the underlying causes of stand/tree susceptibility to attack would not be addressed. The insects would continue to dictate which trees would be harvested and the extent of the harvest until they have eliminated most of the larger diameter classes.

3. **Direct Control.**

"The objective of direct control is to reduce beetle numbers to levels that do not cause economically important damage, or to reduce the rate of population expansion in order to implement a longer-term solution" (McMullen et al. 1986). There is no general agreement among scientists and foresters regarding the effectiveness of direct control in reducing losses. Nevertheless, there may be limited application to the Prosser stands until long-term prevention management can be enacted. However, certain disadvantages should be

recognized. The Prosser stands are not isolated from other sources of infestation. Once begun, successful direct control must continue as long as there is evidence of beetle activity as indicated by yearly surveillance. It is difficult to detect every green infested tree even in small areas, and the success of direct control is dependent upon the thoroughness in all aspects of treatment application and of surveillance. Finally, the mountain pine beetle will remain a threat to a susceptible stand even with successful control unless conditions creating the susceptibility are alleviated by long-term management.

**a. Sanitation Logging.** The removal of infested trees for utilization, which kills the beetles, is the most commonly used method of direct control. It would appear suitable in the Prosser stands because the area is small, readily accessible and a limited number of trees are involved.

**b. Pile and Burn.** The infested portions of currently infested trees could be cut into short lengths, piled on the stumps, and burned until the bark is completely charred on all logs. This brood-killing technique is time-consuming and restricted by fire hazard conditions, but is very adaptable to winter conditions.

**c. Peel.** Infested trees can be felled and the bark peeled from the boles while the broods are in the larval and pupal stages. The bark is more easily removed in the spring than the winter. The bark can be either burned or placed in the sun to quickly desiccate. Crews from the Nevada Department of Corrections were recently used for applying this method to an infestation of Jeffrey pine beetle at South Lake Tahoe.

**d. Insecticide Treatment.** Infested trees could be felled, bucked if necessary, and the infested bole area sprayed uniformly to drip point with a bark-penetrating solution of insecticide in fuel oil. Dursban™ and lindane are available for use (see Appendix I for specimen labels and example "Special Local Need").

Many types of spray equipment can be used as long as the parts are resistant to the oil and the nozzle delivers a cone-shaped or fan-shaped spray. Fuel oil alone is also an effective treatment when sprayed to drip point on infested logs which are then tightly covered with plastic sheeting (McMullen et al. 1986).

Application also can be made on standing trees. The equipment should be capable of spraying to 30 ft high on the bole, which means approximately 80 psi pump pressure. This technique is more unwieldy than spraying felled trees and a great deal more spray can hit non-target surfaces.

Spraying felled or upright infested trees is best carried out in the spring or early summer before the emergence and flight period. Infested trees are easier to find because of faded foliage and weathering and woodpecker activity will have provided cracks and holes in the bark that aid penetration.

Sevinmol™ 4 carbaryl insecticide can be used as an economically sound preventative treatment when the number of standing, infested trees to be treated is low and their value high (see Appendix I). Removal of infested trees and the destruction of the broods before flight would still be advisable to increase the probability of survival of treated trees.

## 4. Preflight Pheromone Trapping

**a. Tree Baiting.** This methodology is not presently available because the registration requirements are currently under review by the EPA. However, it may be available for use next year. Baiting of uninfested, untreated or pesticide-treated trap trees has two purposes: to trap and kill flying beetles attracted to the trap, and to serve as a nucleus for a spot infestation that can be treated later (McMullen et al. 1986). The general procedures of how to use semiochemicals are contained in the Technical Bulletin by Phero Tech. Inc.[1] (Phero Tech. 1985) and an example is given in Borden et al. (1983).

Tree baiting is highly effective in inducing beetles to attack selected trees. This increases the effectiveness and feasibility of the direct control methods previously mentioned. The tree must be baited prior to beetle flight and should be at least 10-12" dbh in the Prosser stands. The commercially available lures containing three chemicals are attached to the tree on the north side and above the understory canopy.

Lethal trap trees are prepared by thoroughly spraying boles to the drip point to a height of 15 ft with a nonpenetrating insecticide. A preparation of 2% a.i. carbaryl in water prepared from Sevin™ SL is usually effective in killing the beetles attracted to the baited trees (McMullen et al. 1986). Baited trees untreated with insecticide are also effective traps but generally trap fewer beetles than lethal trap trees and the likelihood of attacks on adjacent treesis greater than with lethal trap trees. There also is the disadvantage that infested trap trees and any adjacent attacked trees must be treated following attack to kill beetles and their broods.

**b. Funnel Trapping.** Funnel trapping is another technique for manipulating mountain pine beetle populations. The traps absorb nearby populations without the tree mortality associated with trap trees. The method apparently does not require registration, but the strategy needs more research and development. Results in Canada have been encouraging. However, the use of funnel traps in stand conditions such as Prosser is only a delaying tactic until long-term management actions, such as thinning, can be implemented.

## 5. Preventive Management

**a. Thin.** The harvest of the stands would eliminate the problem and financial returns would be realized. However, the objective of retaining forest cover and screening would be sacrificed. Thinning could be used to reduce stocking and remove the larger trees that characterize susceptible stands. Cover would be retained, a firewood sale realized, and the stand converted to a less susceptible condition.

Selectively removing trees on the basis of diameter and phloem thickness is one way to effectively reduce bark beetle hazard, eg. removal of pines greater than 14" dbh at Prosser Creek. However, this type of "high grading" may not be an acceptable practice. Basal area and improvement leave cuts (thinning from below) will effectively reduce or minimize loss and may be more acceptable.

---

1. The mention of products does not imply endorsement by the USDA-Forest Service, nor does the exclusion of certain products imply disapproval.

The stand record card projections of 140 BA after thinning seem about right for stands 389 and 391. Stand 388 would be thinnned to about 110 sq ft.

Thinning, once started in older stands containing large diameter, thick-phloemed pines, must be carefully planned and faithfully carried out until the stands are replaced by regeneration cutting to produce age and size mosaics. Failure to carry out subsequent thinnings, necessary to maintain tree vigor, could invite further attack.

**6. Annosus Root Disease Management**

During thinning for mountain pine beetle management, the resource manager has an opportunity to practice effective annosus root disease management by the use of a simple stump treatment. The most effective control for annosus root disease is prevention. The application of borax (sodium tetraborate decahydrate, EPA Reg. No. 1624-94) to all freshly-cut conifer stumps will prevent most new infections in the area. The borax should be applied according to label directions, including application as soon after felling as practical. Application immediately after cutting is most efficient. This treatment is required on all conifer stumps created in and around developed recreation sites (see FSM 2303 R-5 Supplement No. 126, and 2331.33 R-5 Supplement No. 90). Although the Prosser stands are not developed for recreation, the aesthetic value of the trees in this dispersed recreational setting may warrant annosus disease prevention.

From strictly a disease management point-of-view, application of borax would be the prudent course of action. Since the management objective for the stands is to maintain a vigorous and healthy tree cover, borax treatment now may prevent or greatly reduce any annosus root disease problems in the future stand. The efficacy between disease prevention now and the ineffective or costly control procedures after infection occurs needs to be considered. Management of active annosus centers developing 20 to 30 years from current thinning activities may be more costly than management of the mountain pine beetle problem now. However, several economic and biological factors also need to be considered.

a. The cost of borax treatment may be prohibitive. If 200 stumps per acre are created in the 87-acre area during thinning, and if a borax treatment cost of $1 per stump is assumed, the total cost for borax treatment would be $16,000.

b. A requirement for borax treatment would preclude opening the stands for fuelwood cutting by the public. Contracting the thinning operation, and requiring borax application in the contract, would probably add to the overall administrative costs of the project. Some of this increased cost may be offset by more efficient thinning operations by a commercial operator.

c. The number of annosus centers that may develop in the stands without borax treatment is unknown. Information from Region 5 and other areas in the West suggest that adverse impacts of annosus root disease in lodgepole pine stands is not common. This may be due to unfavorable edaphic conditions for the fungus (wet, heavy soils) in areas where lodgepole pines often grow, to the relative lack of management (creating stumps) in lodgepole pine stands, or to other factors. However, F. annosus is relatively common in the area on Jeffrey pine, the soils are, for the most part, moderately-to well-drained, and at

least some infection of lodgepole pine stumps would be expected. Although our knowledge of annosus infection in lodgepole pine is sketchy, it is known that stumps of the species are susceptible to spore infection, that losses from F. annosus in other pine species have increased as management increased, and that losses have been associated with stumps left from thinnings.

## PEST BIOLOGIES

### Annosus Root Disease

Fomes annosus is a fungus that attacks a wide variety of woody plants. All western conifer species are susceptible. Madrone (Arbutus menziesii), and a few brush species (Arctostaphylos spp. and Artemisia tridentata) are occasional hosts. Other hardwood species are apparently not infected. The disease has been reported on all the National Forests in California, with incidence particularly high on true fir in northern California campgrounds and on ponderosa and Jeffrey pines in the eastside pine type.

During periods favorable to the fungus, fruiting bodies (conks) form in decayed stumps, under the bark of dead trees, or under the duff at the root collar. New infection centers begin by aerial spread of spores produced by the conks and subsequent colonization of freshly cut stump surfaces or wounds on living trees. The fungus then spreads through root contacts into the root systems of adjacent live conifers. Local spread of the fungus from a stump typically results in the formation of a disease center, with dead trees in the center and fading trees on the margin. These centers usually continue to enlarge until they reach natural barriers such as stand openings or non-susceptible plants. The fungus may remain alive for as long as 50 years as a saprophyte in infested roots and stumps.

In pines, F. annosus grows through root cambial tissue to the root crown where it girdles and kills the trees. In less resinous species such as true fir, the fungus sometimes kills trees, but more frequently it is confined to the heartwood and inner sapwood of the larger roots where it causes a chronic butt and root decay and growth loss.

### Mountain Pine Beetle

The mountain pine beetle, Dendroctonus ponderosae Hopkins, is the insect most destructive of lodgepole pine in California and western North America. Other hosts in the vicinity of Truckee are ponderosa pine, western white pine, sugar pine and whitebark pine. Infestations in lodgepole often become quiet extensive.

One generation per year is usual, but evidence in the Prosser stands indicates that a partial second generation may be present or that the emergence period extends into the autumn. A few live female adults were found at the end of short egg galleries that contained eggs and first stage larvae. These females were constructing what appeared to be either ventilation holes or points of exit. The viability of the eggs found could be questionable because larvae and adults are the usual overwintering stage. A small number of fresh pitch tubes also were found. It was assumed that these were late attacks that did not pitch profusely until spring.

Adults attack trees and lay eggs from June through August. Attacks are usually heaviest along the main trunk of a tree from dbh to mid-crown, but may extend the whole length of the tree. Adults bore 2' to 4' long vertical egg galleries in the phloem/cambium region, and lay eggs in niches along the sides of the gallery. At the bottom of the gallery where construction began is a hook shaped like a hockey stick. The hatching larvae feed in mines perpendicular to the main gallery, and construct small pupal cells at the end of these mines where they pupate and transform into adults.

Damage by the beetle is recognized by pitch tubes along the bole and red boring dust in bark crevices and on the ground. Foliage will fade from green to greenish yellow and eventually reddish brown. The rapidity of fading varies greatly — most pines attacked in 1985 retained their normal green color when the Prosser stands were examined in early May 1986.

## LITERATURE CITED

Borden, J. H., L. J. Chong and M. C. Fuchs. 1983. Application of semiochemicals for the mountain pine beetle, Dendroctonus ponderosae (Coleoptera: Scolytidae), in British Columbia baited tree studies. Can. J. For. Res. 13:325-333.

McMullen, L. H., L. Safranyik, and D. A. Linton. 1986. Suppression of mountain pine beetle infestations in lodgepole pine forests. Infor. Rept. BC-X-276, Pacific For. Centre, Can. For. Serv., Victoria, B.C. 20 p.

Phero Tech Inc. 1985. Technical Bulletin: Mountain pine beetle. Phero Tech. Inc., 1140 Clark Dr., Vancouver, B.C. V5L 3K3.